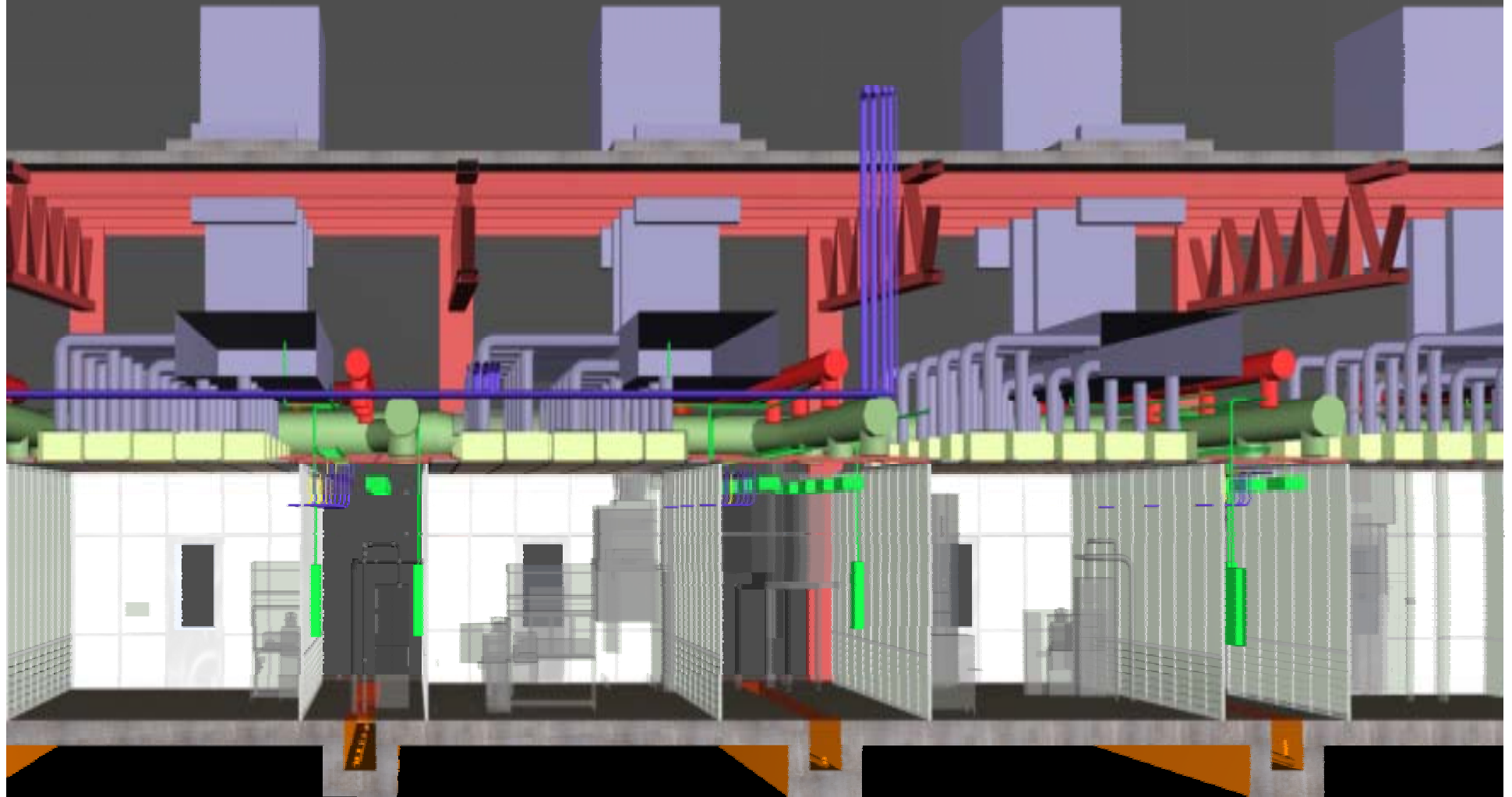


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Sustainable Nanotechnology Research Facilities

Curt D. Finrock, AIA
October 2002

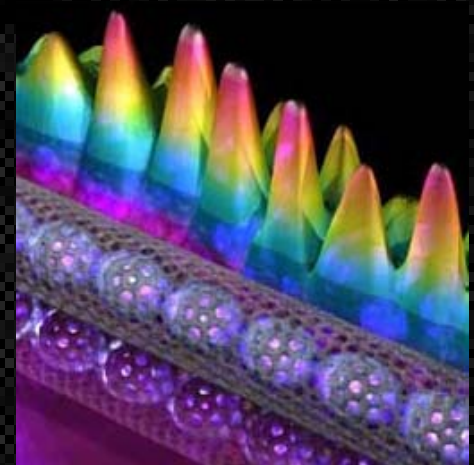
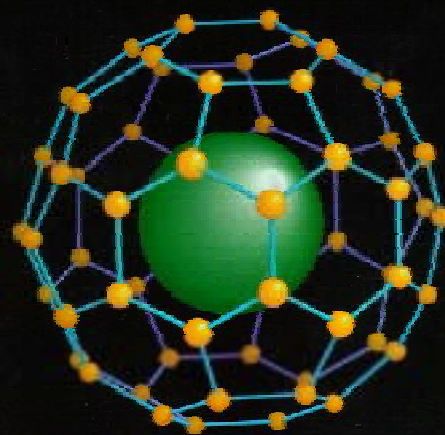
Nanoscale Science

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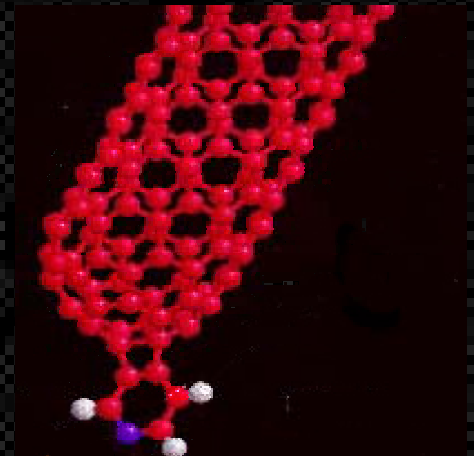
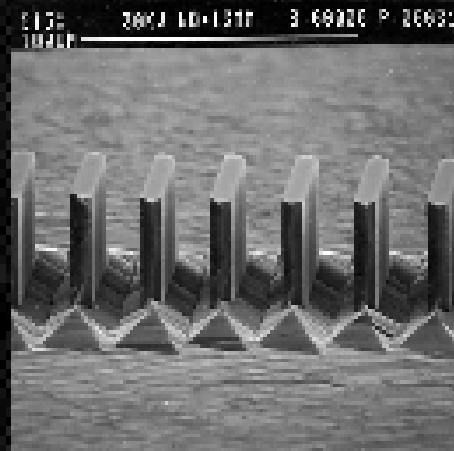
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- Materials
- Biotechnology
- Electronics
- Sensors (MEMS)



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Nanotechnology Facility Characteristics

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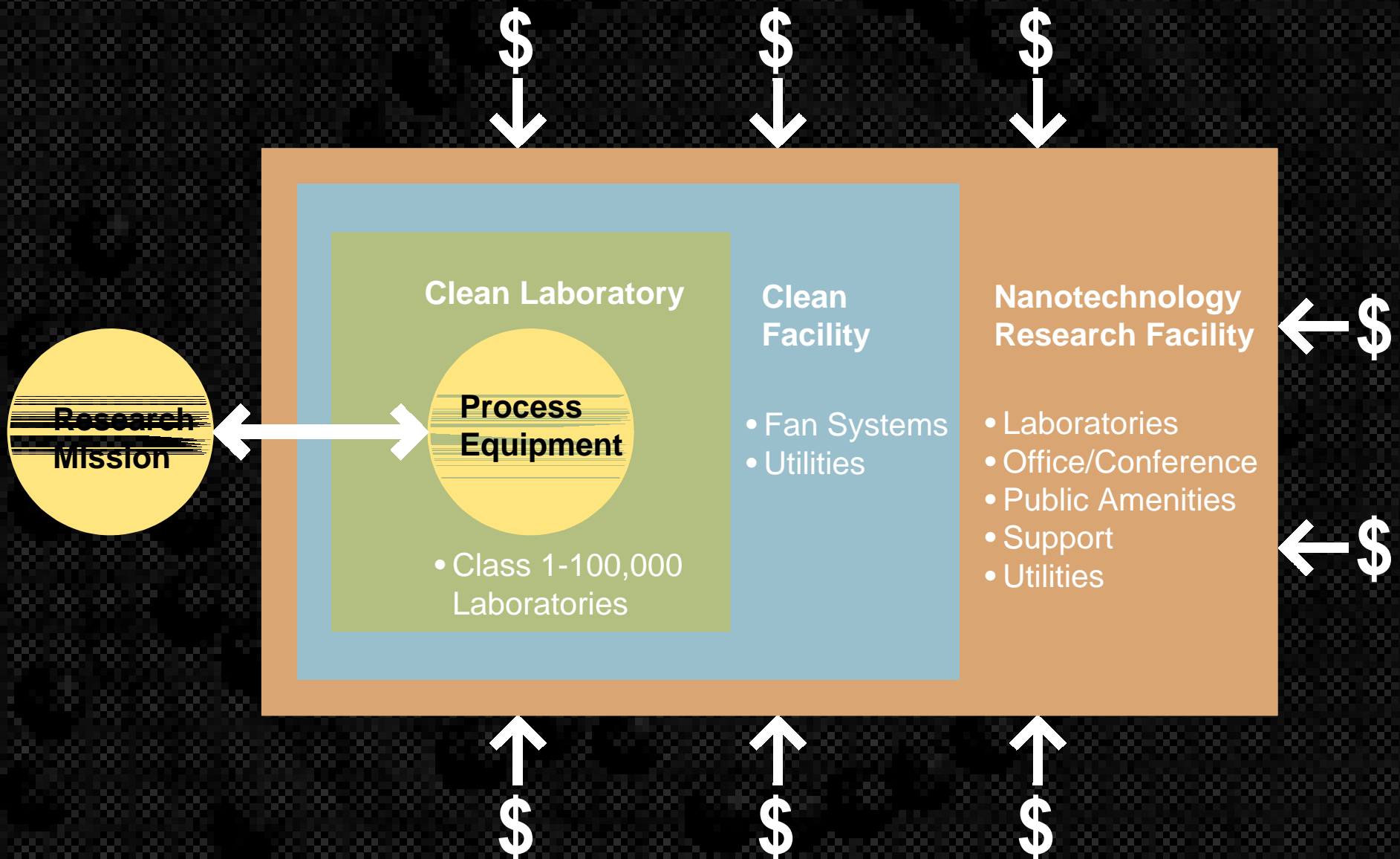
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- Clean Laboratories Class 1-100,000
- Multi- Disciplinary Science through Collaboration
- Exceptionally High Energy Demands
- Construction Costs 3 - 5 Times Conventional Laboratory Costs
- Frequent Rate of Equipment & Utility Modifications



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Conceptual Diagram

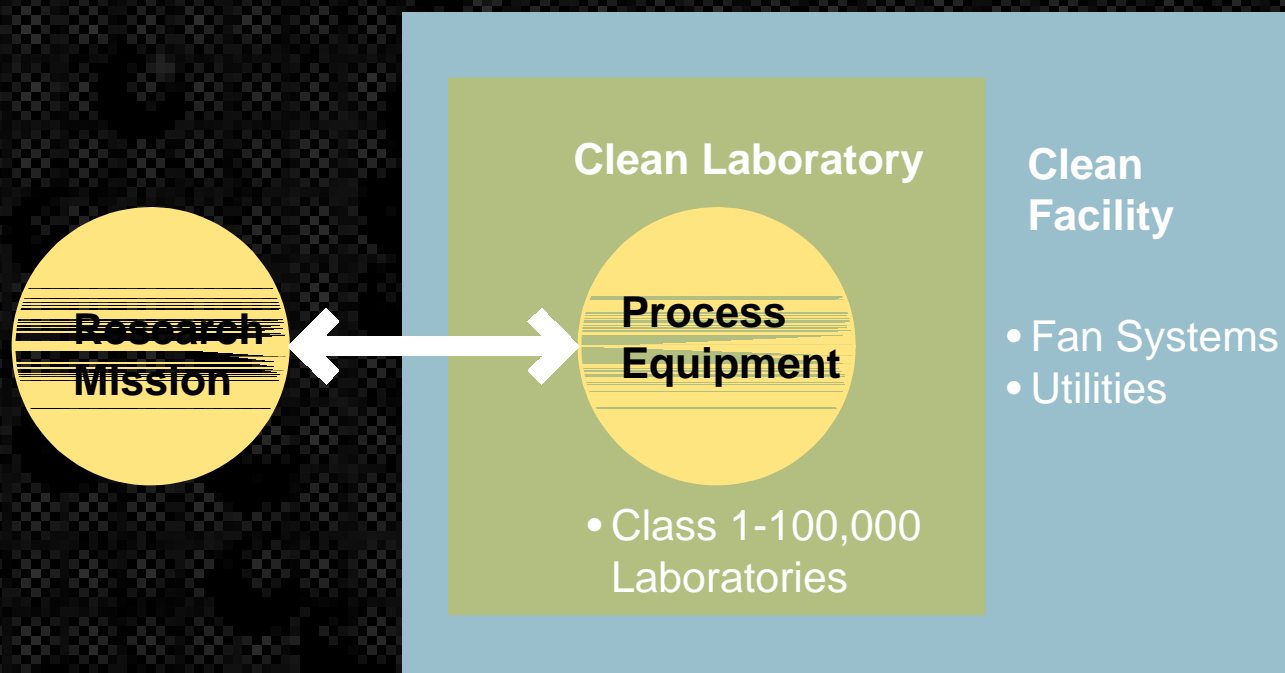


Conceptual Diagram

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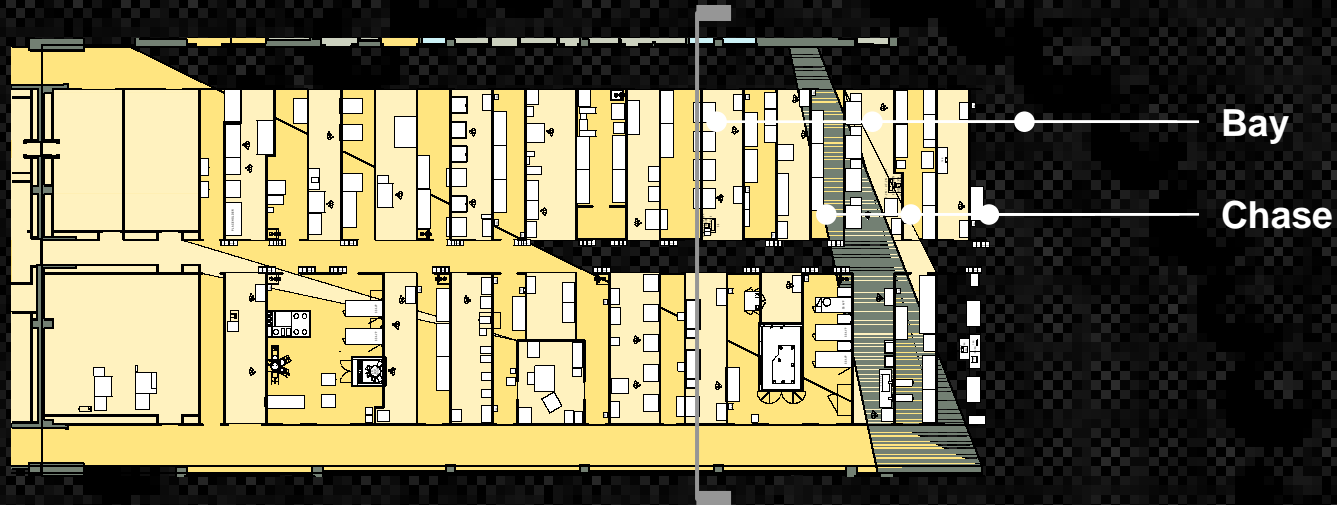
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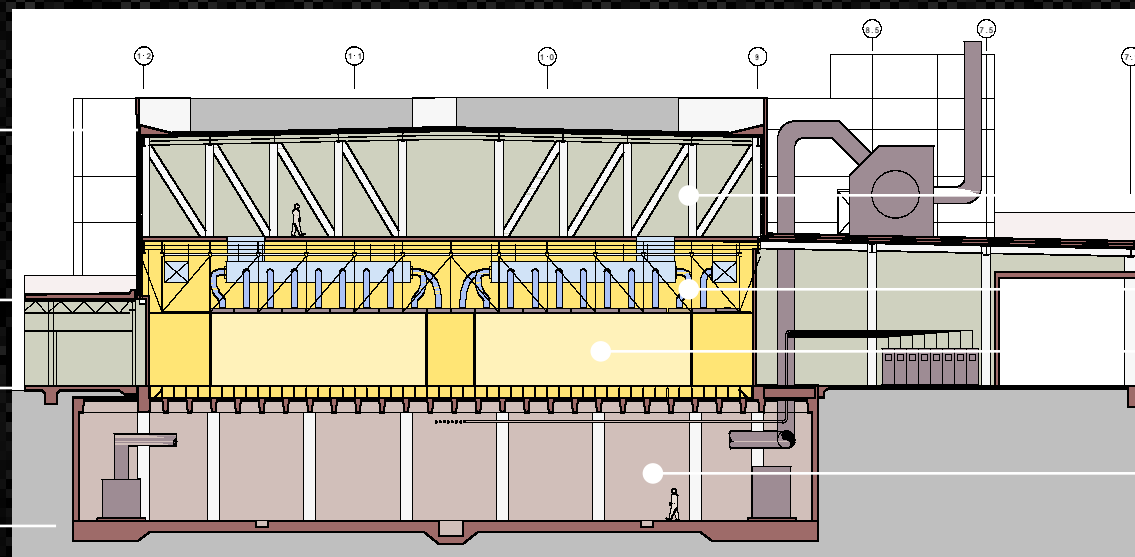
Bay and Chase Clean Laboratory

Floor Plan



60'

12'



Fan Deck

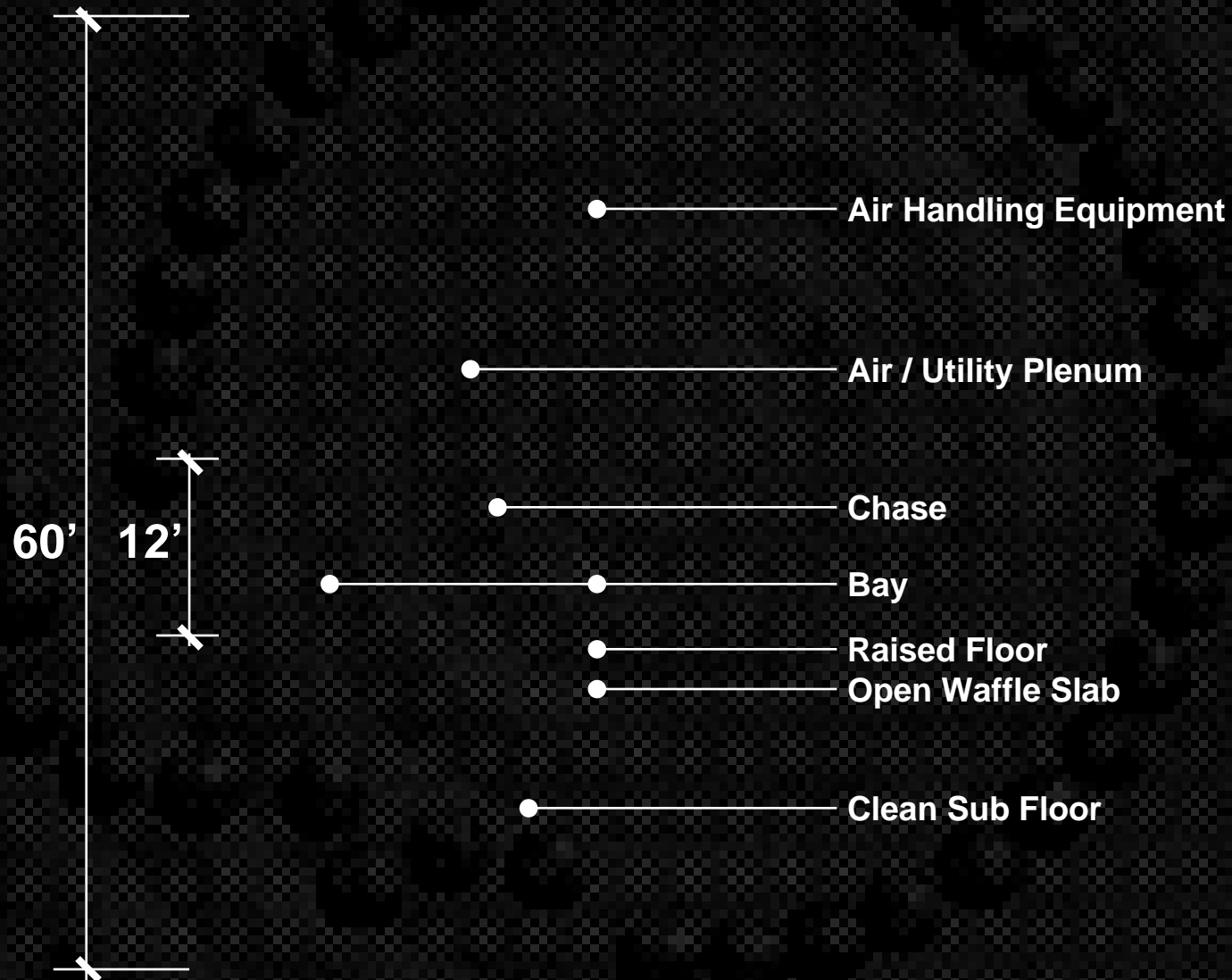
Utility Plenum

Cleanroom

Clean Sub Floor

Cross Section: Microsystems and Engineering Science Application (MESA)

Bay and Chase Clean Laboratory



Enlarged Section

Bay and Chase Clean Laboratory

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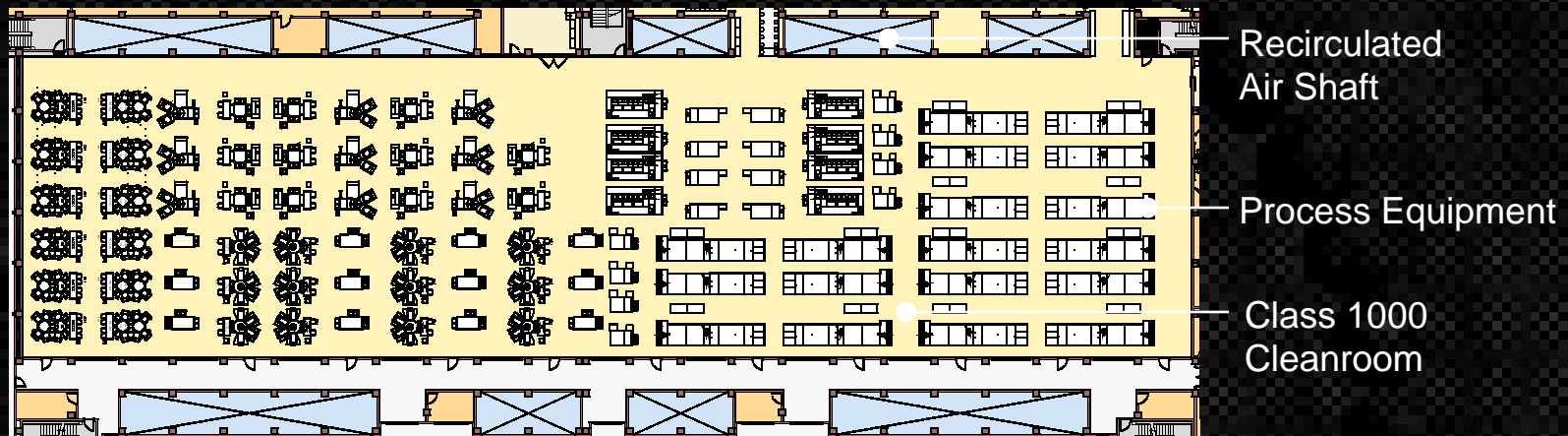
Durham , NC

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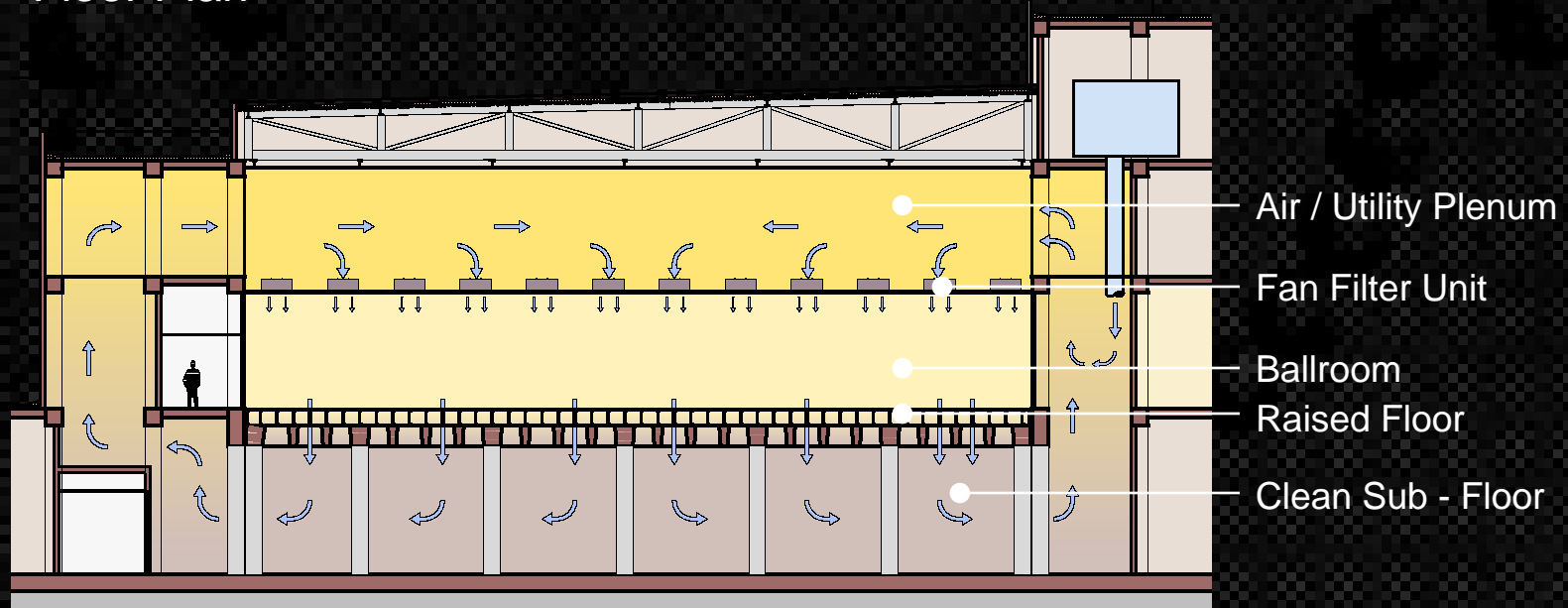


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Ballroom Clean Laboratory



Floor Plan



Longitudinal Section: Albany Nanotech SUNY

Ballroom Clean Laboratories

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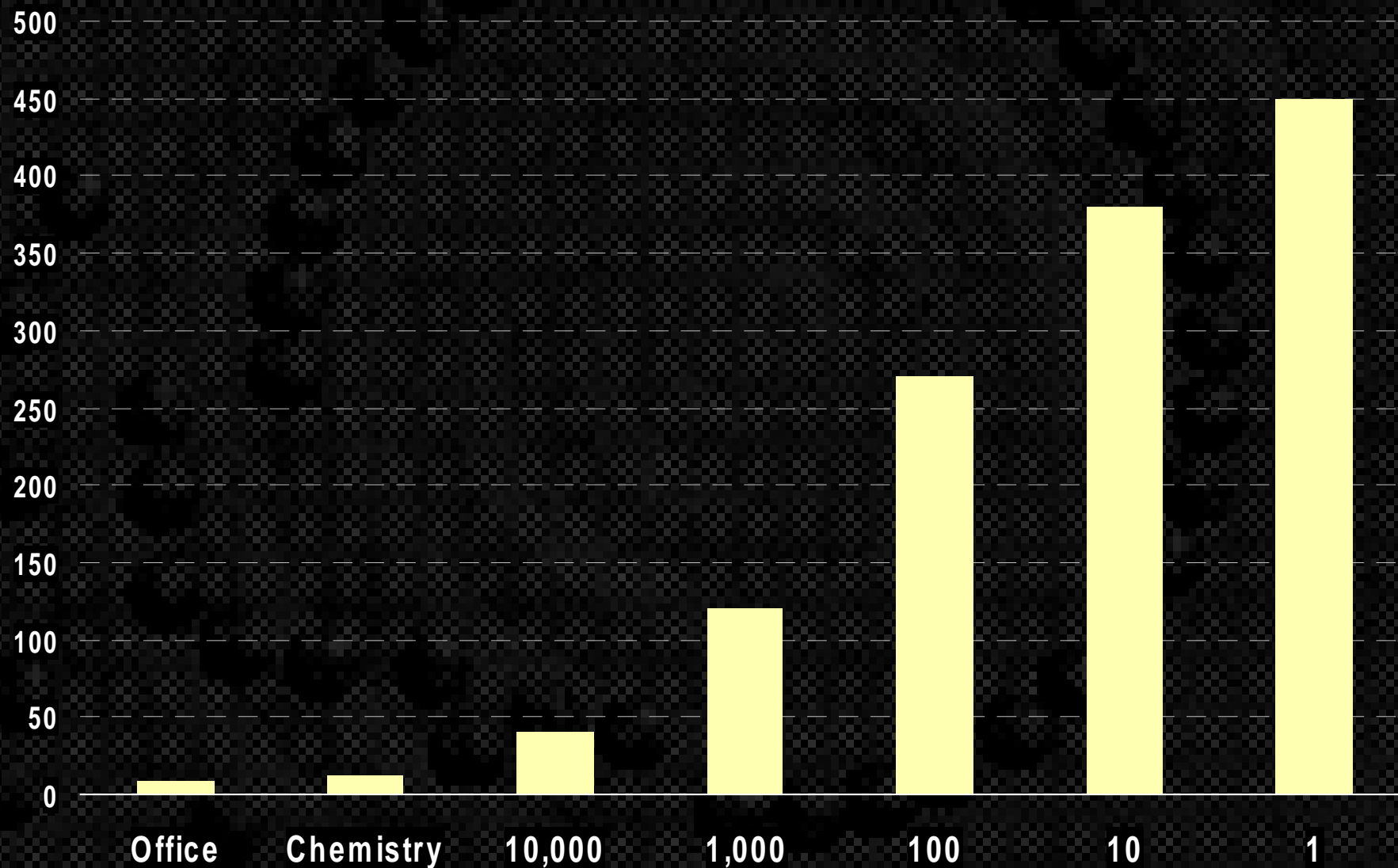
Durham, NC

October, 2002

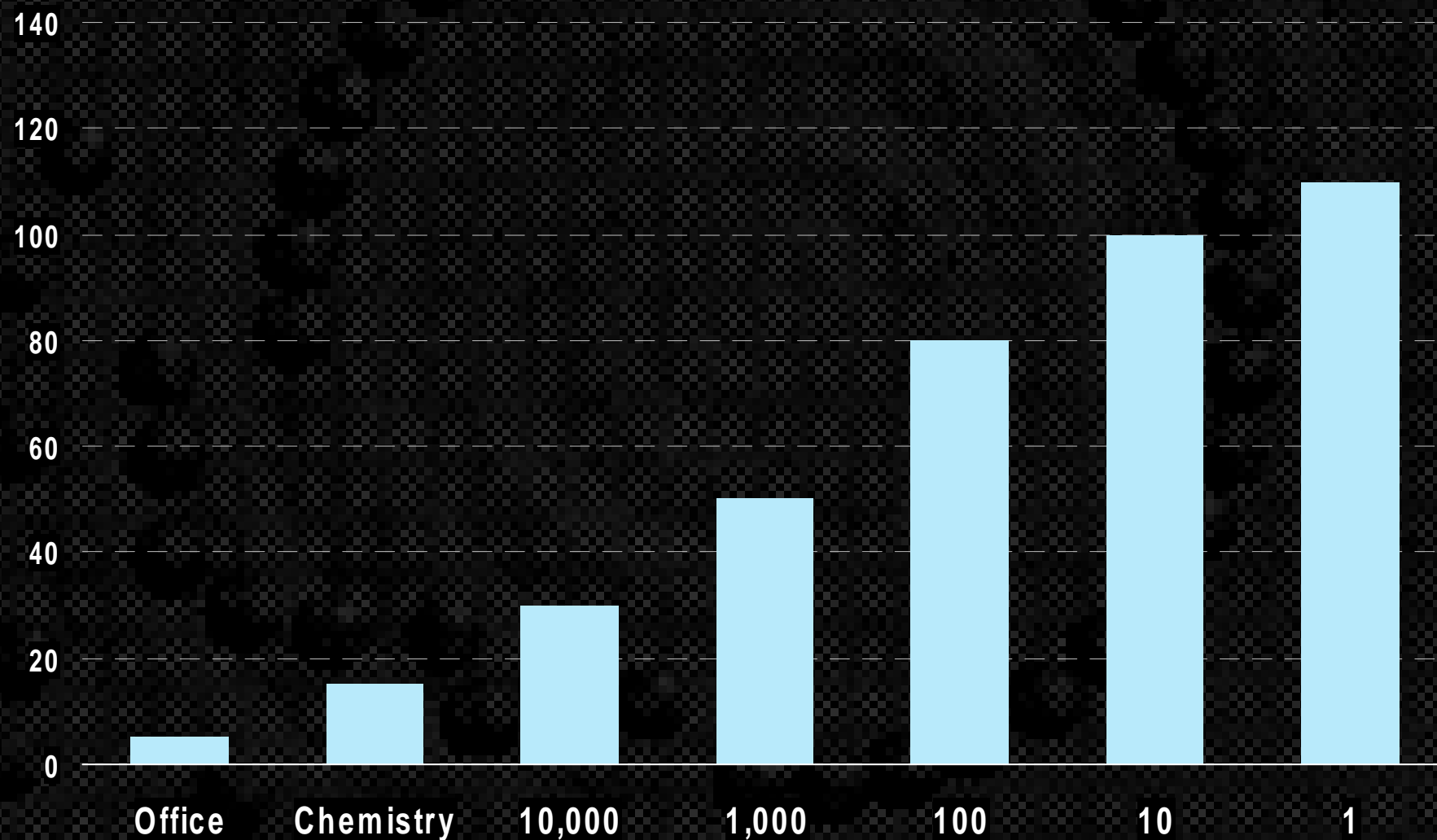


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Comparative Air Changes



Power Usage



Sustainable Sites

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Y	?	N	P1	Erosion & Sedimentation Control	Required
Y	?	N	1	Site Selection	
Y	?	N	2	Urban Redevelopment	
Y	?	N	3	Brownfield Redevelopment	
Y	?	N	4.1	Alternative Transportation, Public Transportation Access	
Y	?	N	4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	
Y	?	N	4.3	Alternative Transportation, Alternative Fuel Refueling Stations	
Y	?	N	4.4	Alternative Transportation, Parking Capacity	
Y	?	N	5.1	Reduced Site Disturbance, Protect or Restore Open Space	
Y	?	N	5.2	Reduced Site Disturbance, Development Footprint	
Y	?	N	6.1	Stormwater Management, Rate or Quantity	
Y	?	N	6.2	Stormwater Management, Treatment	
Y	?	N	7.1	Landscape & Exterior Design to Reduce Heat Islands, Non-Roof	
Y	?	N	7.2	Landscape & Exterior Design to Reduce Heat Islands, Roof	
Y	?	N	8	Light Pollution Reduction	
Y	?	N	9.1	Safety and Risk Management, Air Effluent	
Y	?	N	9.2	Safety and Risk Management, Water Effluent	

- Geographic location may have a significant impact on the clean facility design concept and cost.
- Environmental Safety and Health (ES&H) participation is essential throughout the design process.

Water Efficiency

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Y ? N P1 Laboratory Equipment Water Use Required

Y ? N 1.1 Water Efficient Landscaping, Reduce by 50%

Y ? N 1.2 Water Efficient Landscaping, No Potable Use or No Irrigation

Y ? N 2 Innovative Wastewater Technologies

Y ? N 3.1 Water Use Reduction, 20% Reduction

Y ? N 3.2 Water Use Reduction, 30% Reduction

Y ? N 4.1 Process Water Efficiency, Document Baseline

Y ? N 4.2 Process Water Efficiency, 30% Reduction

- Substantial utility efficiencies can be achieved by understanding equipment requirement and user work habit.
- European laboratories offer intriguing lessons for efficiency and water conservation.

Energy & Atmosphere

Y ? N	P1	Fundamental Building Systems Commissioning	Required
Y ? N	P2	Minimum Energy Performance	Required
Y ? N	P3	CFC Reduction in HVAC&R Equipment	Required
Y ? N	P4	Assess Minimum Ventilation Requirements	Required
Y ? N	1.1	Optimize Energy Performance, 5%	
Y ? N	1.2	Optimize Energy Performance, 10%	
Y ? N	1.3	Optimize Energy Performance, 15%	
Y ? N	1.4	Optimize Energy Performance, 20%	
Y ? N	1.5	Optimize Energy Performance, 25%	
Y ? N	1.6	Optimize Energy Performance, 30%	
Y ? N	1.7	Optimize Energy Performance, 35%	
Y ? N	1.8	Optimize Energy Performance, 40%	
Y ? N	1.9	Optimize Energy Performance, 45%	
Y ? N	1.10	Optimize Energy Performance, 50%	
Y ? N	2.1	Renewable Energy, 5000 BTU/sf	
Y ? N	2.2	Renewable Energy, 10000 BTU/sf	
Y ? N	2.3	Renewable Energy, 20000 BTU/sf	
Y ? N	3	Additional Commissioning	
Y ? N	4	Ozone Depletion	
Y ? N	5	Measurement & Verification	
Y ? N	6	Green Power	
Y ? N	7.1	Energy Supply Efficiency, 10%	
Y ? N	7.2	Energy Supply Efficiency, 20%	
Y ? N	7.3	Energy Supply Efficiency, 30%	
Y ? N	7.4	Energy Supply Efficiency, 40%	
Y ? N	7.5	Energy Supply Efficiency, 50%	
Y ? N	8	Improve Laboratory Equipment Efficiency	
Y ? N	9	Right-size Laboratory Equipment Load	

- Energy performance opportunities will be dependant on cleanroom type and purpose.
- Renewable energy is not a likely priority unless supplemental funding is available.
- Limited options for laboratory equipment selection.
- 20% average equipment utilization rate.

Materials & Resources

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Y ? N	P1	Storage & Collection of Recyclables	Required
Y ? N	P2	Hazardous Material Handling	Required
Y ? N	1.1	Building Reuse, Maintain 75% of Existing Shell	
Y ? N	1.2	Building Reuse, Maintain 100% of Shell	
Y ? N	1.3	Building Reuse, Maintain 100% Shell & 50% Non-Shell	
Y ? N	2.1	Construction Waste Management, Divert 50%	
Y ? N	2.2	Construction Waste Management, Divert 75%	
Y ? N	3.1	Resource Reuse, Specify 5%	
Y ? N	3.2	Resource Reuse, Specify 10%	
Y ? N	4.1	Recycled Content, Specify 25%	
Y ? N	4.2	Recycled Content, Specify 50%	
Y ? N	5.1	Local/Regional Materials, 20% Manufactured Locally	
Y ? N	5.2	Local/Regional Materials, of 20% Above, 50% Harvested Locally	
Y ? N	6	Rapidly Renewable Materials	
Y ? N	7	Certified Wood	
Y ? N	8	Chemical Resource Management	

- Chemical / hazardous material handling is a key safety and code issue.
- Unique building type and advanced technology present numerous obstacles.

Indoor Environmental Quality

Y	?	N	P1	Minimum IAQ Performance	Required
Y	?	N	P2	Environmental Tobacco Smoke (ETS) Control	Required
Y	?	N	P3	Laboratory Ventilation	Required
Y	?	N	1	Carbon Dioxide (CO₂) Monitoring	
Y	?	N	2	Increase Ventilation Effectiveness	
Y	?	N	3.1	Construction IAQ Management Plan , During Construction	
Y	?	N	3.2	Construction IAQ Management Plan , Before Occupancy	
Y	?	N	4.1	Low-Emitting Materials , Adhesives & Sealants	
Y	?	N	4.2	Low-Emitting Materials , Paints	
Y	?	N	4.3	Low-Emitting Materials , Carpet	
Y	?	N	4.4	Low-Emitting Materials , Composite Wood	
Y	?	N	5	Indoor Chemical & Pollutant Source Control	
Y	?	N	6.1	Controllability of Systems , Perimeter	
Y	?	N	6.2	Controllability of Systems , Non-Perimeter	
Y	?	N	7.1	Thermal Comfort , Comply with ASHRAE 55-1992	
Y	?	N	7.2	Thermal Comfort , Permanent Monitoring System	
Y	?	N	8.1	Daylight & Views , Daylight 75% of Spaces	
Y	?	N	8.2	Daylight & Views , Views for 90% of Spaces	
Y	?	N	9.1	Indoor Environmental Safety , CFD Modeling	
Y	?	N	9.2	Indoor Environmental Safety , Fumehood Commissioning	
Y	?	N	9.3	Indoor Environmental Safety , Window and Door Alarms	

- Establishing, maintaining and monitoring cleanliness is paramount.
- Cleanroom panel off - gassing tend disturb process equipment operation.
- Daylighting is controversial in cleanroom and lab areas.
- Environmental safety is a primary planning issue.

Innovation & Design Process

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Y **?** **N** 1.1 Innovation in Design: Specific Title

Y **?** **N** 1.2 Innovation in Design: Specific Title

Y **?** **N** 1.3 Innovation in Design: Specific Title

Y **?** **N** 1.4 Innovation in Design: Specific Title

Y **?** **N** 2 LEED™ Accredited Professional

- Fertile ground for creativity especially in HVAC and process engineering.
- Mini – environment alternatives.
- Greater emphasis should be placed on initial costs / operating costs analyses.
- Integrated user / industrial engineer / facility engineer / architect approach.

Project Totals

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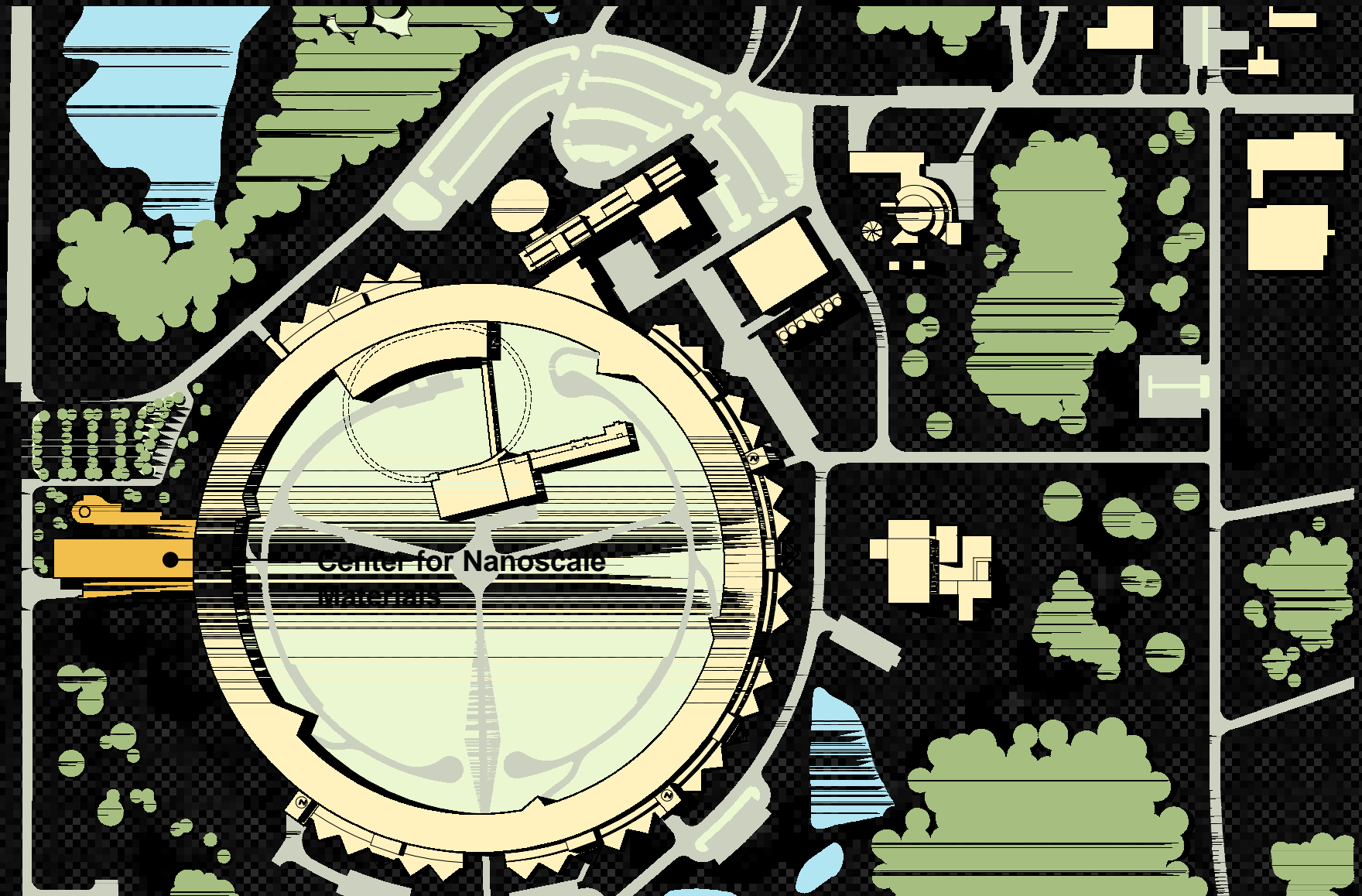
	LEED	LEED + EPC
Sustainable Sites	7 - 8	9 - 10
Water Efficiency	2 - 3	3 - 4
Energy & Atmosphere	2 - 3	11 - 13
Materials & Resources	3 - 4	4 - 5
Indoor Environmental Quality	13 - 14	16 - 17
Innovation & Design Process	3 - 4	4 - 5
<hr/>		
Project Totals	30 - 36	47 - 54

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Site Plan

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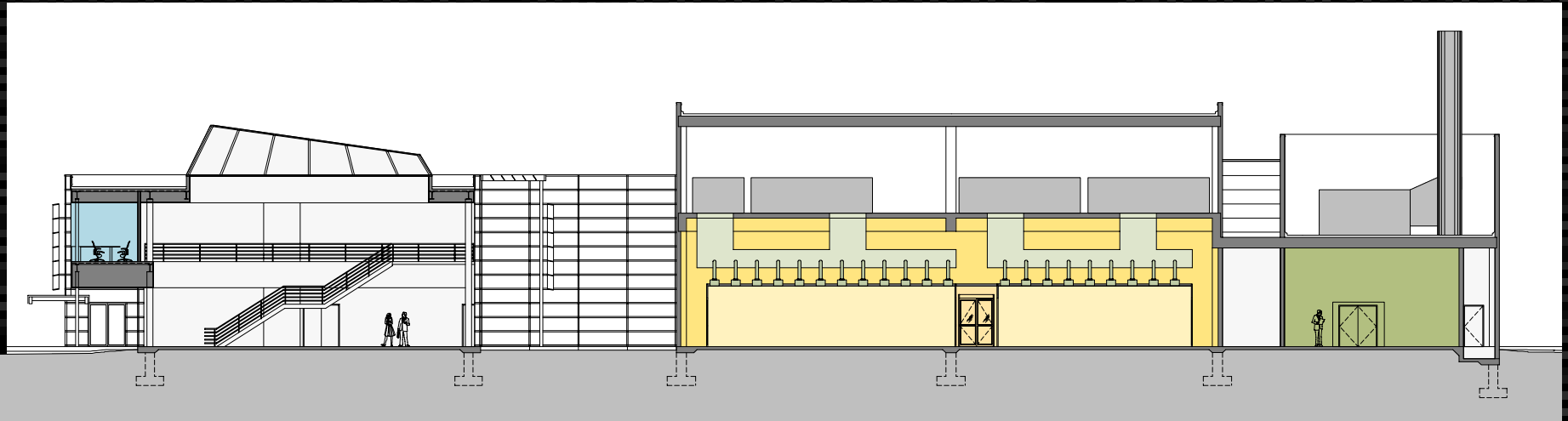


Center for Nanoscale Materials

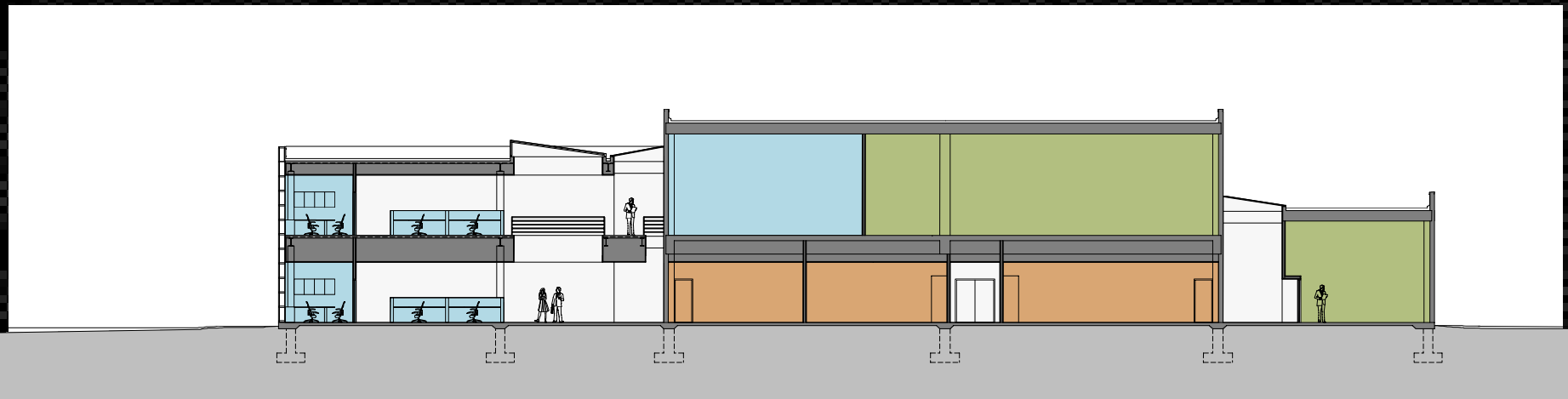
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Cross Section Through Lobby, Cleanroom, and Support



Cross Section Through Office, Labs, and Support

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Center for Nanoscale Materials

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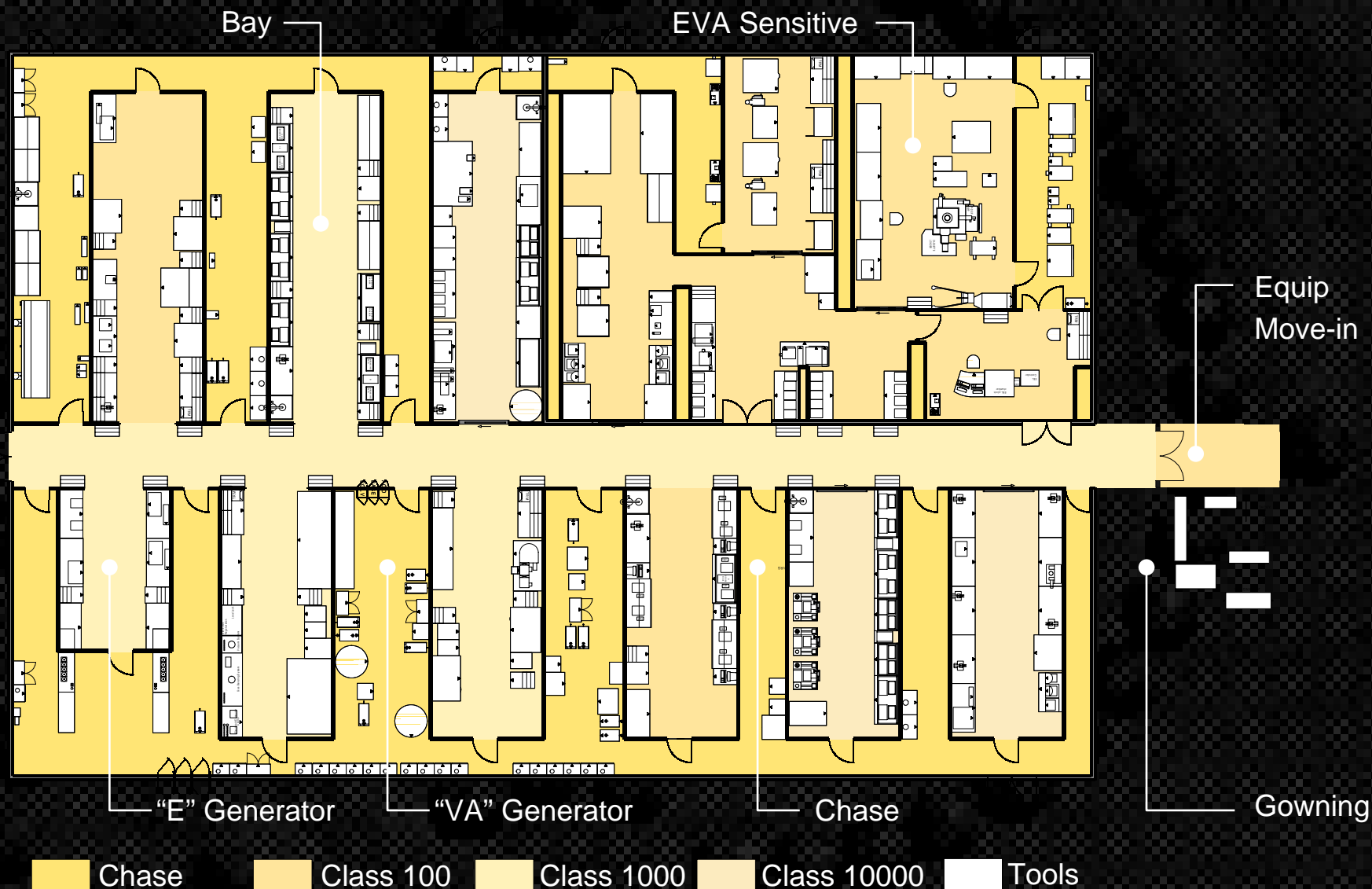
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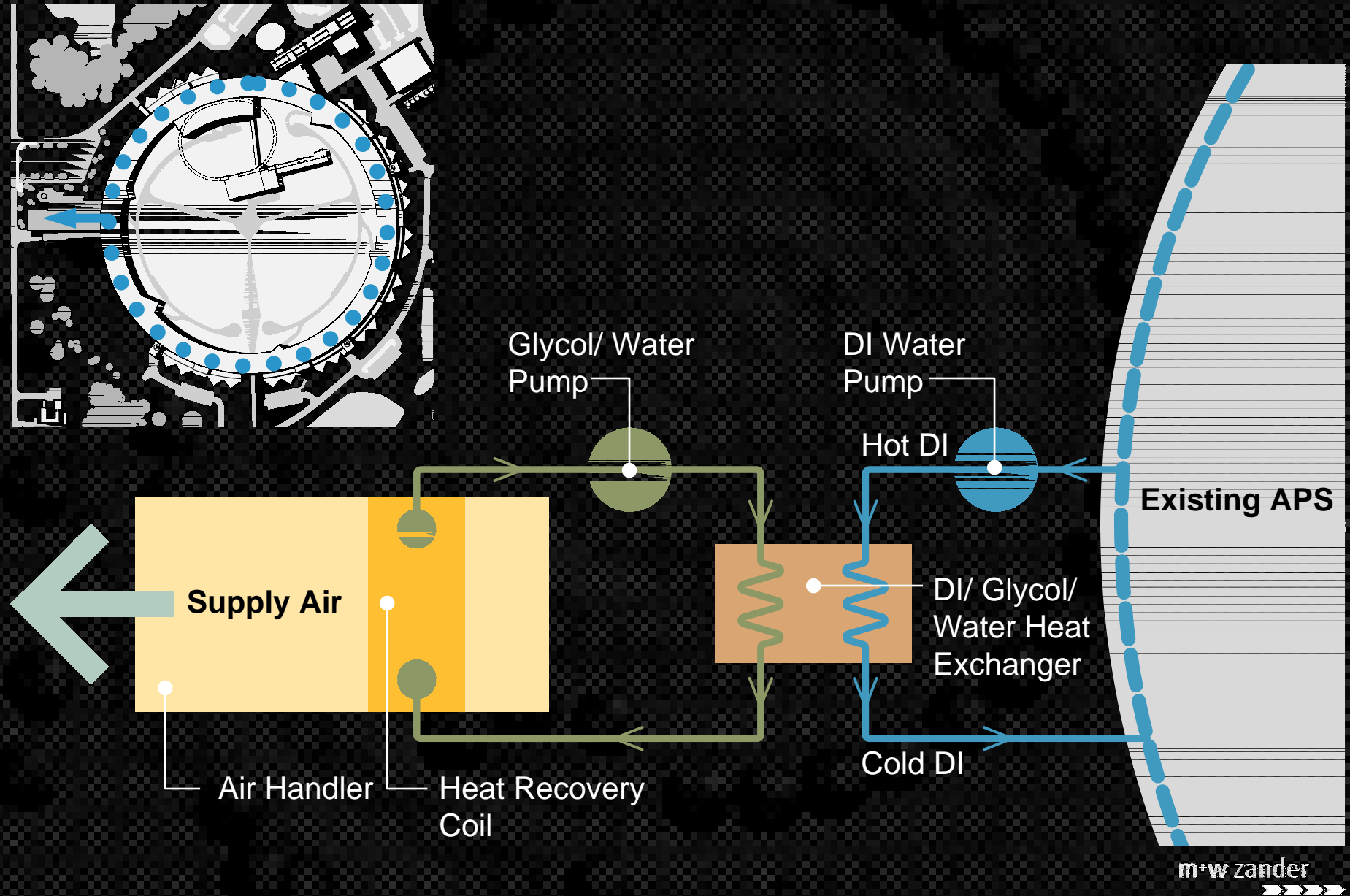
Exterior View

Center for Nanoscale Materials



Cleanroom Plan

DI Water Heat Recovery System

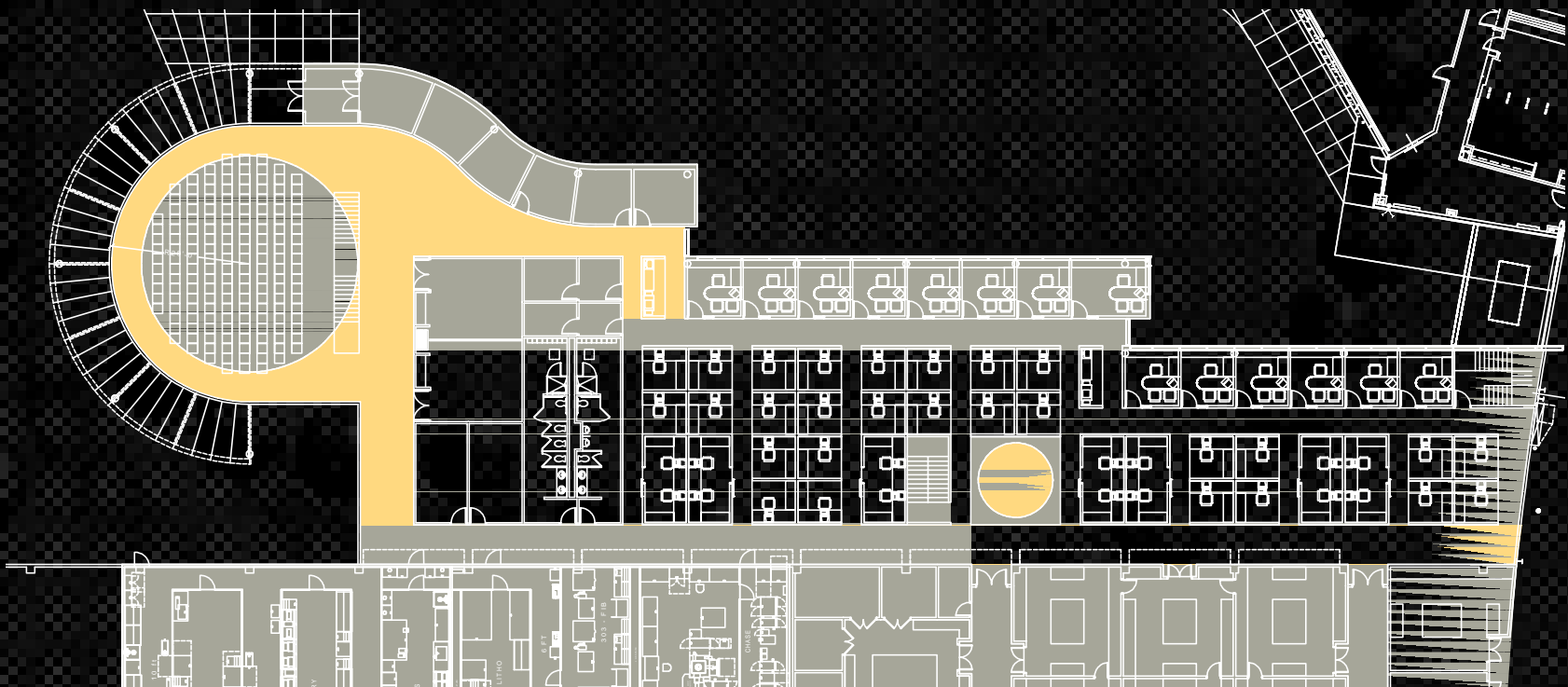


Alternative Finish Floor System

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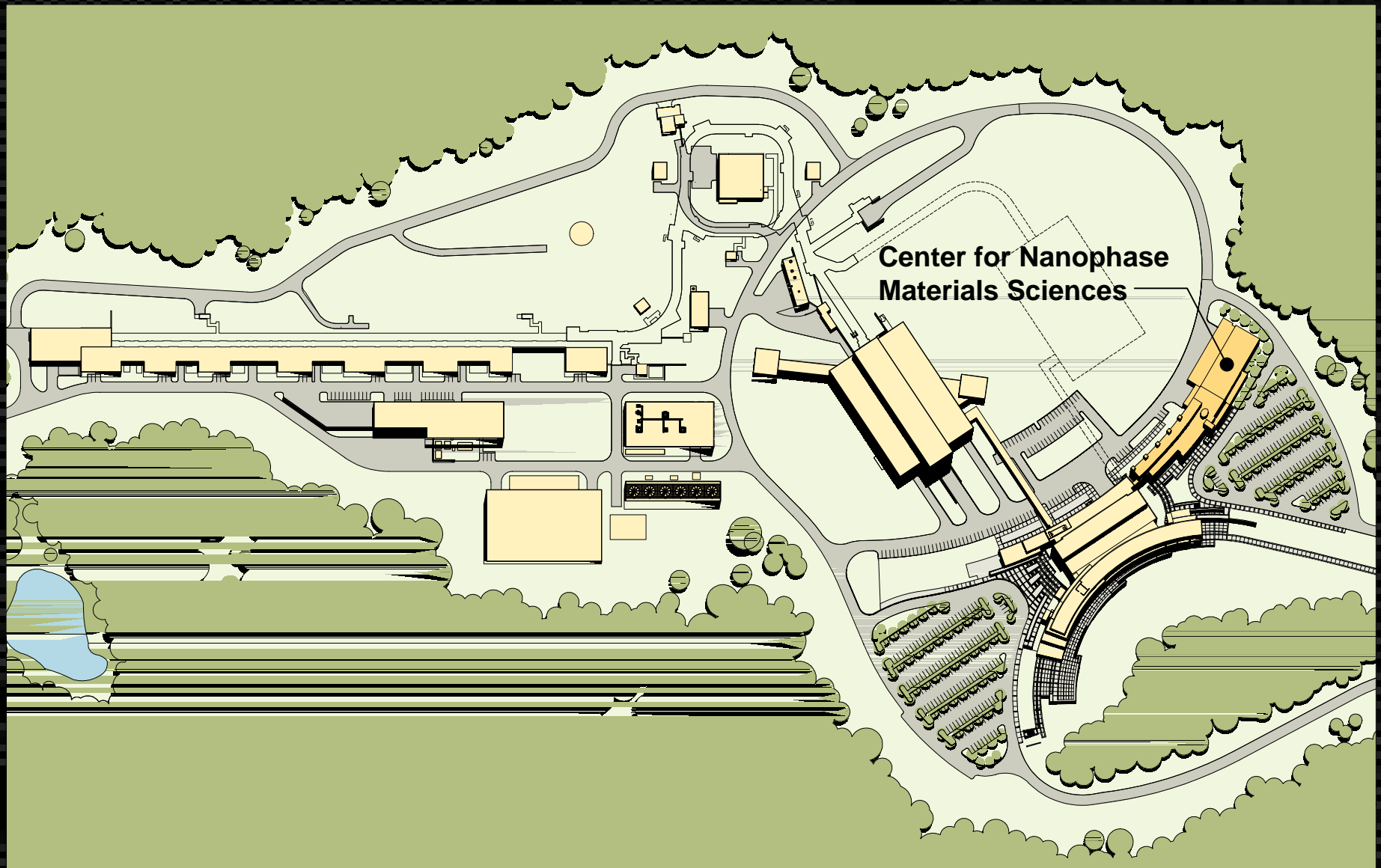
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Center for Nanophase Materials Sciences

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Site Plan

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Center for Nanophase Materials Sciences

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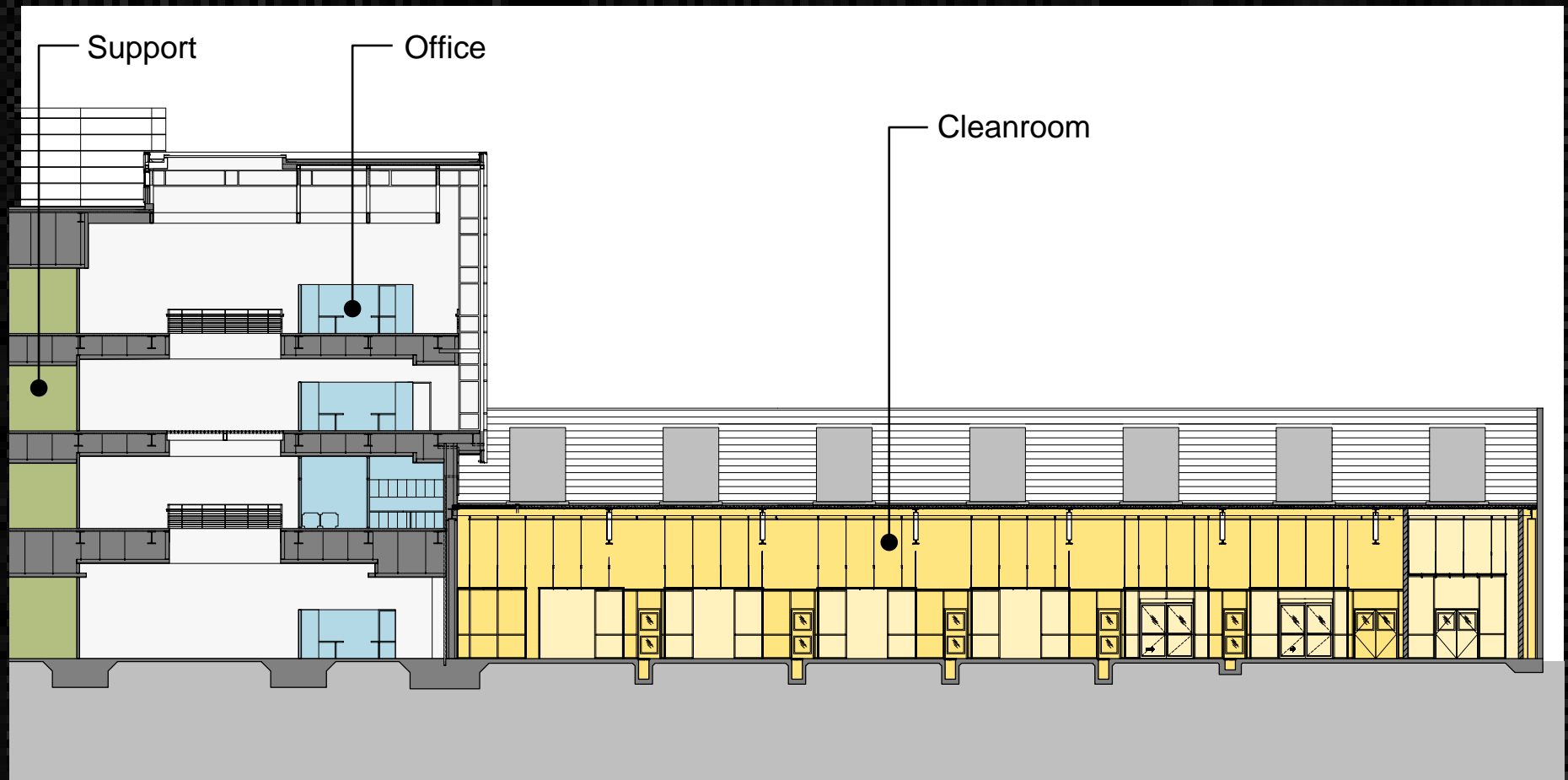
Ground Floor Plan

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Section

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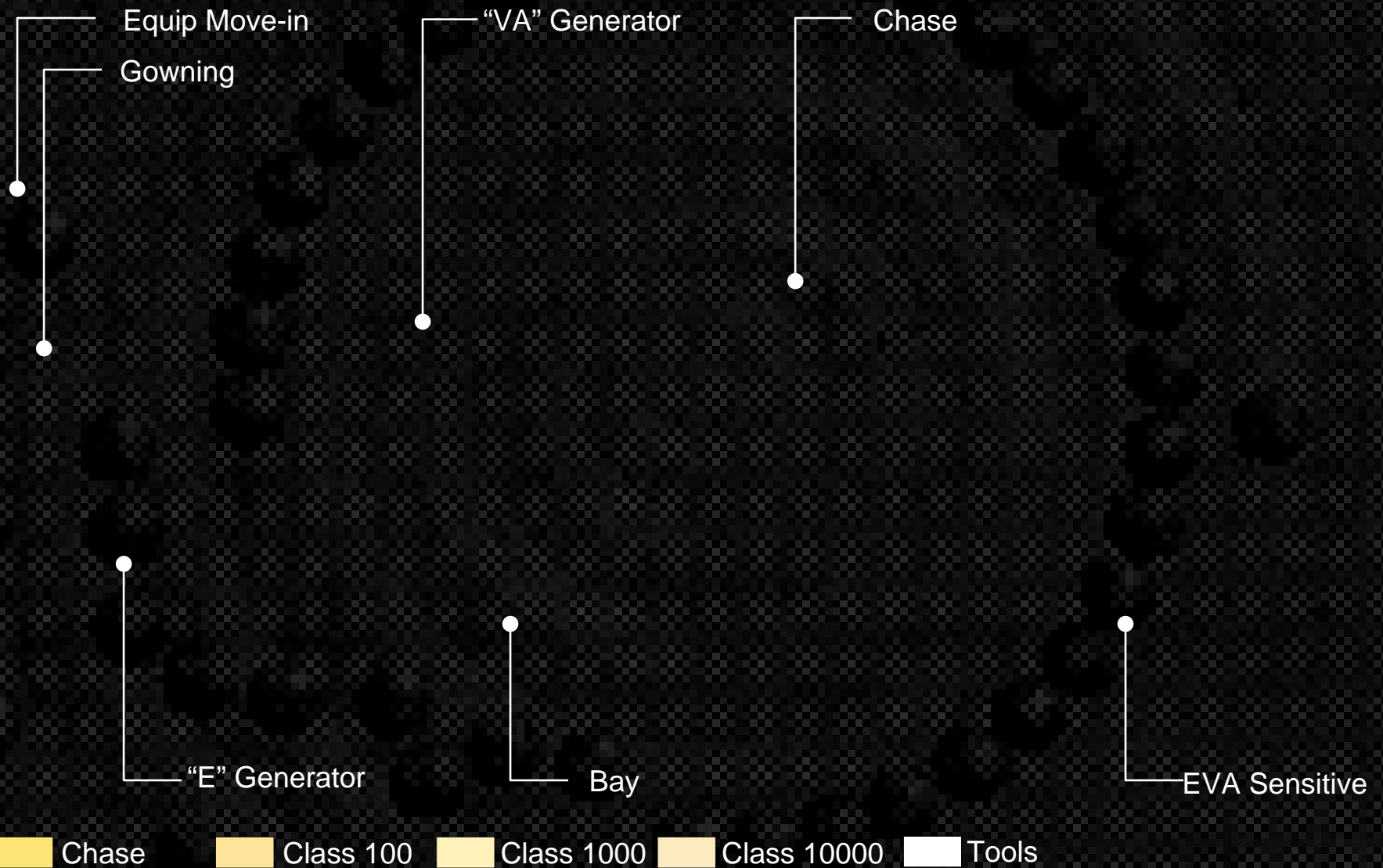
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Cleanroom Plan

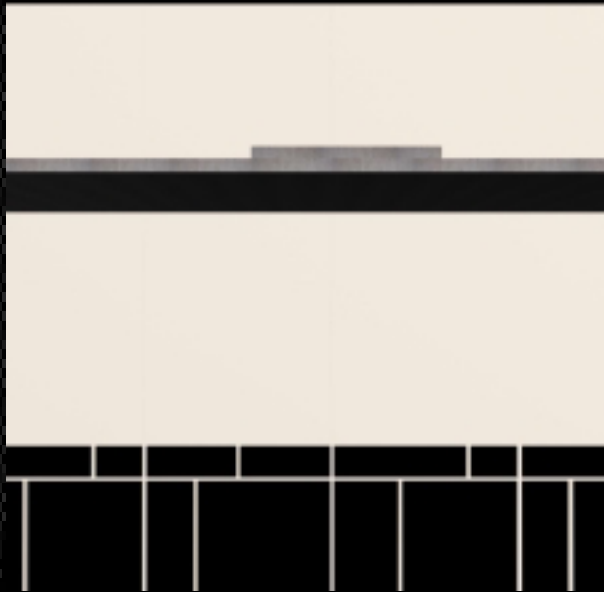
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Cleanroom Enclosure

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Cleanroom Structure

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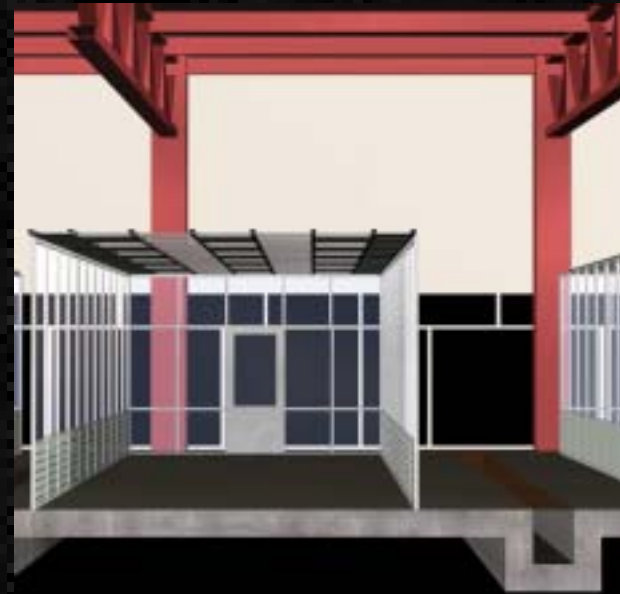
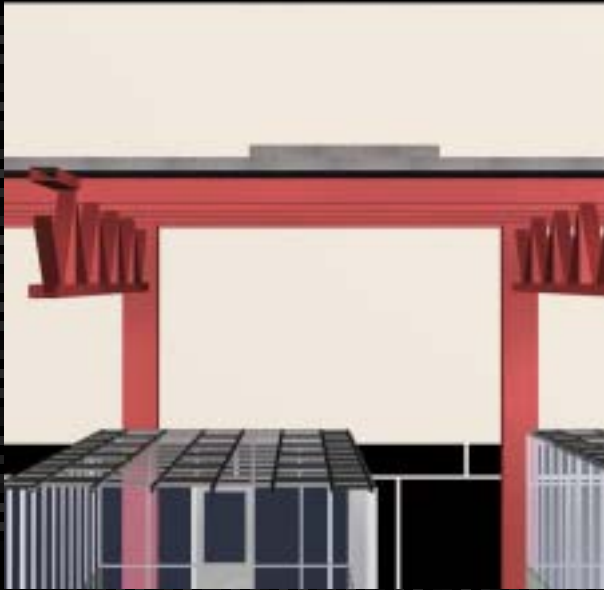
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Process Bay Enclosure

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Process Equipment

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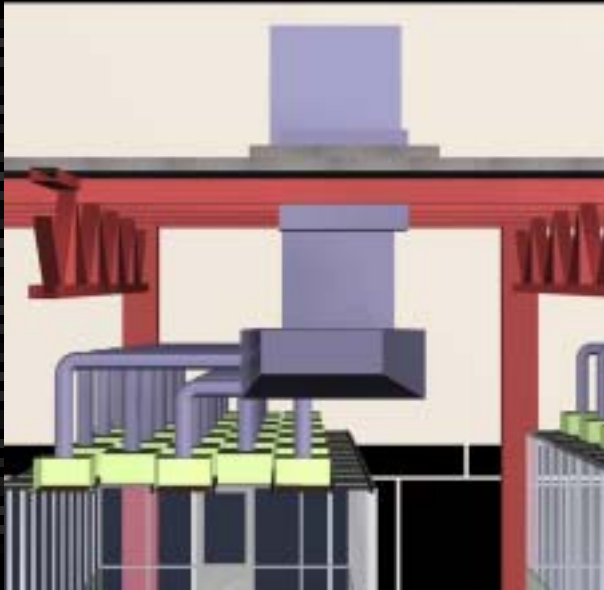
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Cleanroom Supply Air Systems

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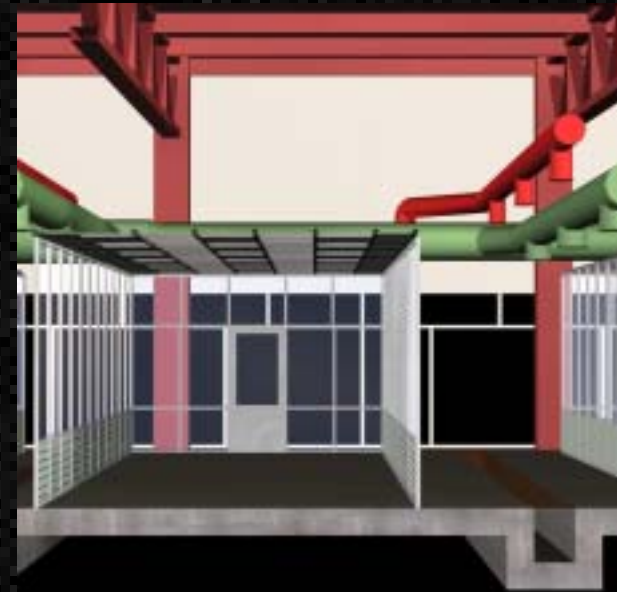
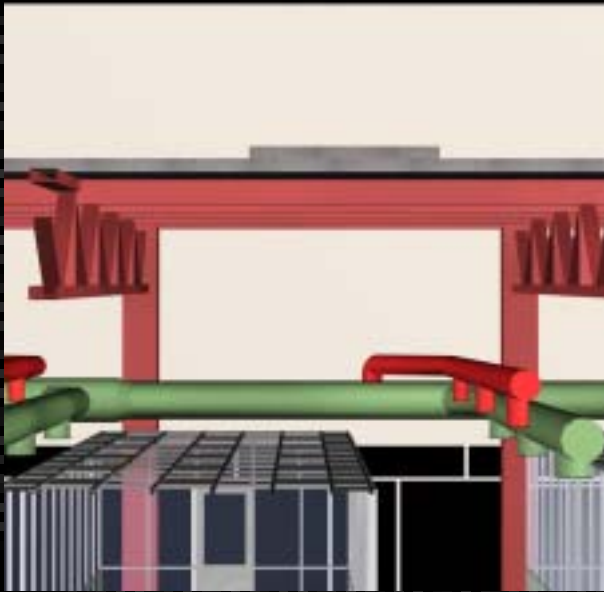
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Cleanroom Exhaust Systems

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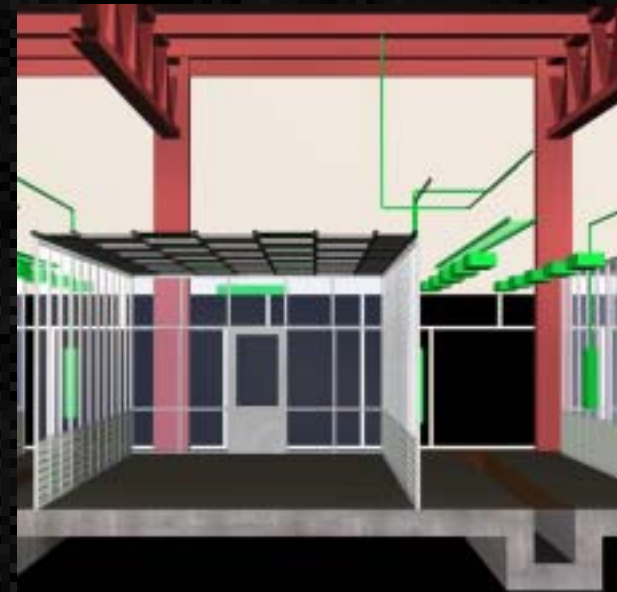
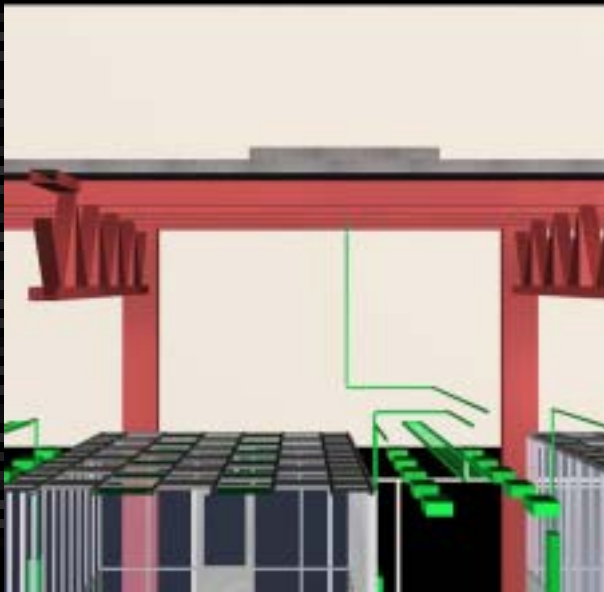
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Cleanroom Electrical System

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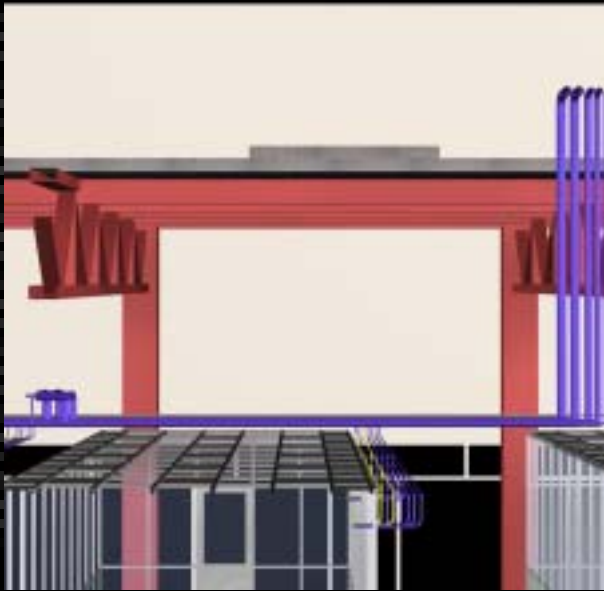


Cleanroom Piped Utility Systems

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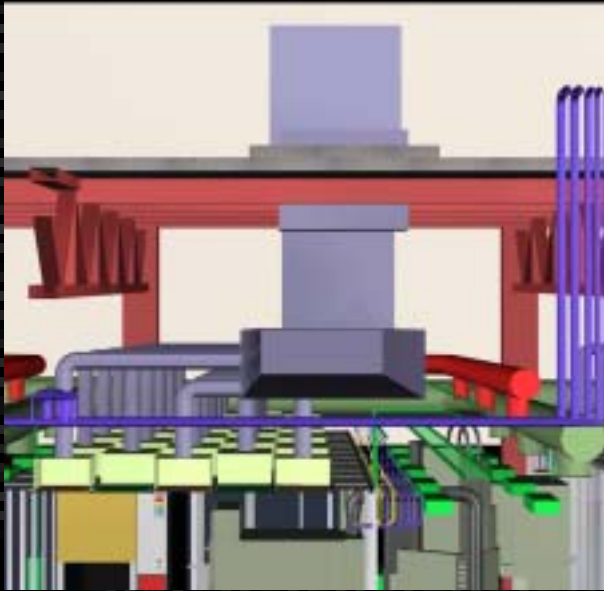
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Cleanroom Composite Systems

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